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## A novel technique for securing tracheal blood supply in salvage anterior mediastinal tracheostomy

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## ABSTRACT

**INTRODUCTION:** The only way for complete cure of advanced esophageal cancer with invasion to the mid-trachea is anterior mediastinal tracheostomy (AMT), which has a significantly high risk of fatal complications. The shorter tracheal stump is beneficial for good blood supply, but complicates to create a tracheostomy.

**PRESENTATION OF CASE:** A 71-year-old patient with a history of advanced cervical esophageal cancer who was treated with definitive chemoradiotherapy 3 years earlier had local recurrence on the left side of the trachea despite salvage lymphadenectomy for solitary left paratracheal lymph node recurrence 1 year earlier. AMT involving a resection of nearly the whole trachea was needed for complete resection. However, the recurred tumor was localized on the tracheal left side. We designed the new surgical procedure to preserve a longer segment of the unaffected right tracheal wall by diagonal cut (3.6 cm longer than on the left side) while maintaining adequate blood flow by preserving the right lateral vascular pedicle in a state of connecting with the right lobe of the thyroid gland and the right tracheal stump. The postoperative course was uneventful, and at 1 year postoperatively, no tumor recurrence has been detected.

**DISCUSSION:** Preservation of the lateral vascular pedicle enables a longer tracheal stump by securing sufficient blood supply and a longer tracheal stump in AMT, even when unilateral, enables to create tracheostomy more surely, preventing fatal complications.

**CONCLUSION:** This novel procedure should be considered in cases with tumor invasion extending into the lower mid-trachea that is limited to one side.

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## 1. Introduction

Anterior mediastinal tracheostomy (AMT) allows complete resection of advanced esophageal cancer with invasion to the mid-trachea [1]. However, the short tracheal stump not only complicates tracheostomy but also increases the risk of fatal bleeding due to a fistula between the trachea and great vessels. To prevent these complications, it is crucial to preserve the blood supply of the tracheal stump as well as to protect the brachiocephalic artery, to fill the dead space, and to create a tracheostomy with tension-free sutures on the skin flap using, for example, the omentum, pectoralis major, or latissimus dorsi flap [2,3]. The trachea is usually transected horizontally to avoid ischemia of the tracheal stump and to maintain an adequate surgical margin. The tracheal vascular supply is derived from the lateral longitudinal system [4,5], the preserva-

tion of which is the most important for maintaining blood supply to the tracheal stump [5].

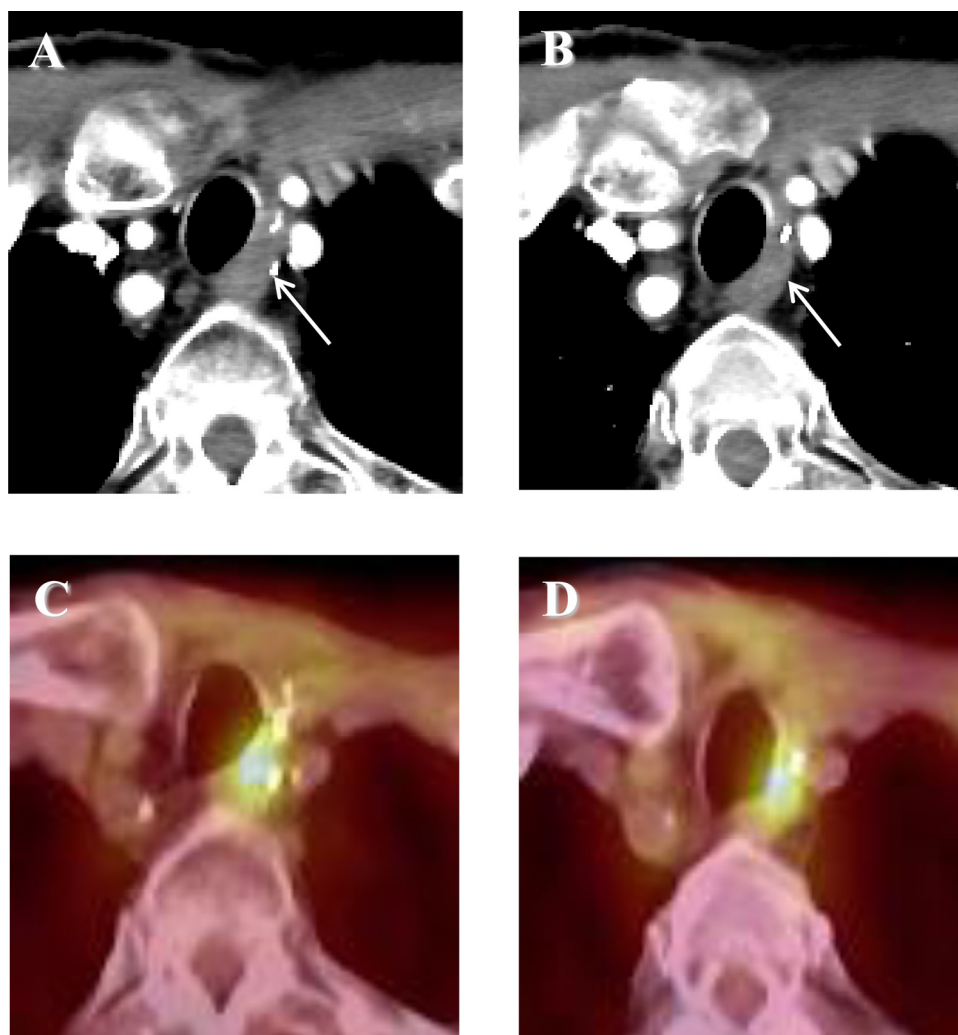
Here, we present the first report of new technique for maintaining the circulation of the tracheal stump in AMT, by preserving the lateral vascular pedicle of the unaffected (right) side along with the ipsilateral lobe of the thyroid gland and leaving a longer ipsilateral tracheal wall by using a diagonal cut.

## 2. Presentation of case

The patient underwent definitive chemoradiotherapy (dCRT, 50 Gy) for advanced cervical esophageal squamous cell carcinoma with bilateral paratracheal lymph node metastases (LNMs) at the age of 68 years. Despite achieving complete response, solitary recurrence of the left paratracheal LNM occurred 2 years later and salvage lymphadenectomy with resection of the left half of the manubrium along with the left proximal clavicle and 1st/2nd ventral ribs was performed. However, local recurrence in the absence of other lesions occurred 1 year later when the patient was 71 years old (Fig. 1) and AMT was performed.

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**Fig. 1.** Two preoperative serial image slices showing the recurrent tumor. (A, B) Computed tomography (arrows) and (C, D) positron emission tomography (yellow bright areas).

First, the right half of the residual manubrium, right proximal clavicle, and 1st/2nd ventral ribs were resected. Afterwards, the larynx, entire trachea, and esophagus were freed from cicatricial adhesions to the great vessels and mobilized. The recurrent tumor was localized to the left side and had invaded the tracheal wall to a distance 2 cm above the bifurcation of the left main bronchus. Because resection of nearly the whole trachea would be required for curative resection when the trachea was transected horizontally, we designed the following new surgical procedure to preserve a longer segment of the unaffected right tracheal wall while maintaining adequate blood flow.

First, the right superior and inferior thyroid vessels were preserved. Second, the right lobe of the thyroid gland was separated from the tracheal cartilages along with the right lateral vascular pedicle (Fig. 2A). Third, the tracheal incision line was diagonal, and a margin >1 cm from the caudal edge of the tumor was maintained. Fourth, the right lateral vascular pedicle was peeled to a distance that was slightly below the incision line (Fig. 2A). Finally, the trachea was cut along the line with Metzenbaum scissors (Fig. 2B). The tracheal stump was connected with the right lobe of the thyroid gland through the preserved right lateral vascular pedicle (Figs. 2C, 3A and B); the residual right tracheal wall was longer than on the left side by 3.6 cm (Fig. 2B and D). The left side of the tracheal stump was just above the ostium of the left main bronchus and was dorsal to the aortic arch. Therefore, the tracheal stump was re-

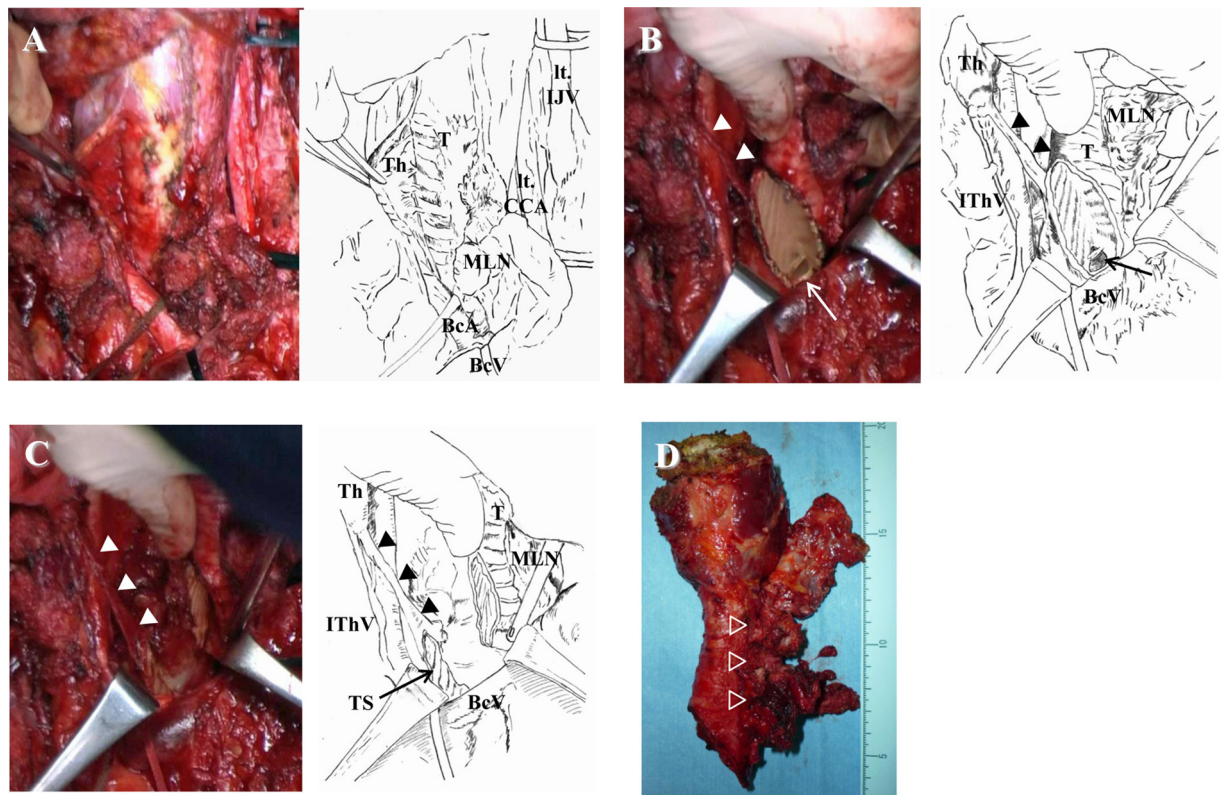
cated to a position between the brachiocephalic artery and superior vena cava after resection of the left brachiocephalic vein. Subsequently, the upper half of the esophagus was resected, enabling en bloc resection of the recurrent tumor (Fig. 2D). Next, approximately 60 cm of free jejunum was harvested along with the vascular pedicle (Fig. 4A), and the esophagus was reconstructed with a portion of the jejunum along with vascular anastomosis. Then, after sacrificing the jejunum (Fig. 4B), except for the portion used as an esophageal graft, the surplus mesenteric fat was used to fill the dead space and cover the great vessels (Fig. 4C and D). Lastly, a wide skin flap of the left anterior chest wall was created by extending the median skin incision to the left side in an L-shape, and a tracheal stoma was completed with the skin flap rotated clockwise (Fig. 3C–E).

Postoperatively, the patient recovered well and no ischemia of the tracheal stump was observed. At 1 year postoperatively, no tumor recurrence has been detected and he has been able to perform daily activities at a nearly normal level.

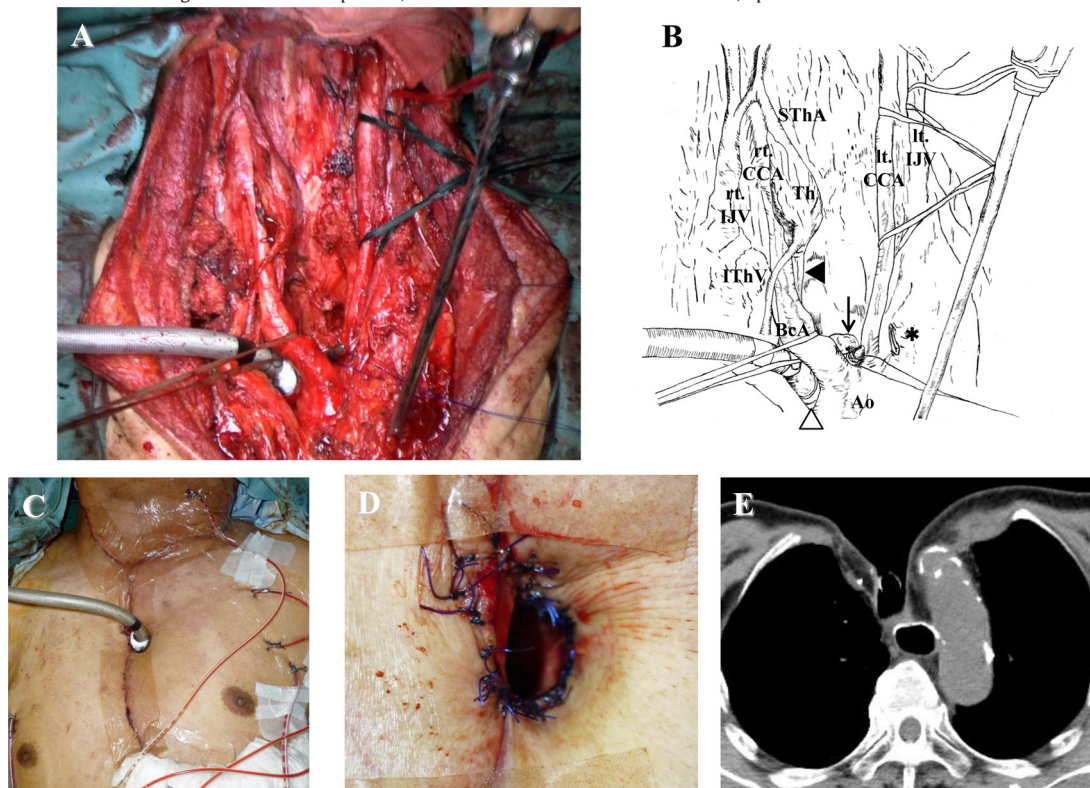
### 3. Discussion

To preserve the length of the residual tracheal stump as much as possible in AMT, it is critical to maintain the blood supply to the end of the tracheal stump. The trachea receives its blood supply primarily from branches of the inferior thyroid artery and the subclavian

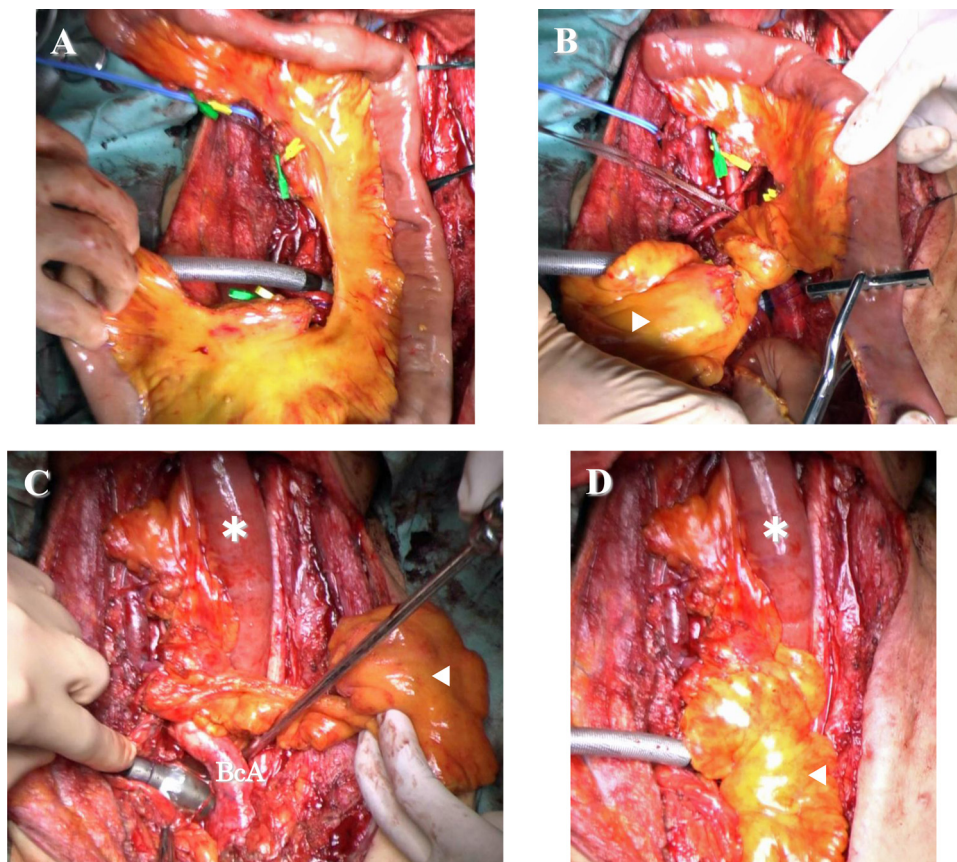




**Fig. 2.** Intraoperative findings. (A) Peeling off the right lateral vascular pedicle from the tracheal cartilages and the right lobe of the thyroid gland. (B) Diagonal cut of the anterior wall of the trachea. (C) After transection of the trachea. (D) Resected specimen. Solid arrowheads: Preservation of the right lateral vascular pedicle; arrow: ostium of the left main bronchus; open arrowheads: tumor invasion into the tracheal wall.



**Fig. 3.** (A) Intraoperative photograph and (B) schema after en-bloc resection of the recurrent tumor. (C) View of the chest wall immediately after the operation showing the skin flap. (D) Close-up shot of the anterior mediastinal tracheostomy. The tracheal bifurcation can be seen at the back of the tracheostomy. (E) Axial CT image showing the anterior mediastinal tracheostomy. Ao: Aorta; BcA: brachiocephalic artery; CCA: common carotid artery; IJV: internal jugular vein; Th: thyroid gland; SThA: superior thyroid artery; IThV: inferior thyroid vein; rt.:right; lt.:left; \*: left stump of left brachiocephalic vein; solid arrowhead: preservation of the right lateral vascular pedicle; open arrowhead: tracheal stump; arrow: stump of the esophagus.



**Fig. 4.** Intraoperative findings (A) the jejunum harvested as a graft. (B) The surplus jejunum was divided from the mesentery. (C) Before and (D) after covering the brachiocephalic artery with surplus mesenteric fat following reconstruction with free jejunum.

artery, and the bronchial arteries, all of which are linked by lateral longitudinal anastomoses in the connective tissue adherent to the tracheal wall [5]. In esophageal cancer surgery, the esophagus is freed completely from the trachea. In addition, paraesophageal lymph node dissection in the cervicothoracic region results in the division of almost all the tracheoesophageal branches. As a result, the blood supply of the thoracic trachea is from the lateral vascular pedicle that is supplied by the bronchial and thyroid arterial systems. Therefore, additional transection of the trachea severs the lateral vascular pedicle and results in decreased blood flow to the stump. Theoretically, if the connection of the lateral vascular pedicle to the thyroid can be preserved, the tracheal stump should receive adequate blood flow from both the bronchial and thyroid arterial systems. In fact, no necrosis of the tracheal wall, mucosa, or tip of the tracheal stump was observed in this case despite dCRT. It is very important to peel off the lateral vascular pedicle while keeping the blood flow of the lateral longitudinal anastomosis intact. For this purpose, a sharp cut with Metzenbaum scissors rather than electrocautery scalpel is considered to be useful.

By preserving a long section of the tracheal wall in AMT, even when unilateral, the drop of the residual tracheal bifurcation into the posterior mediastinum can be avoided by pulling up the ligatures at the longer edge of the stump and suturing the longer tracheal end to the skin flap. The shorter end of the stump can be sutured more surely, which decreases the likelihood of wound dehiscence and a fistula between the trachea and great vessels.

#### 4. Conclusion

This new procedure should therefore be considered in cases with tumor invasion extending into the lower mid-trachea that is

limited to one side. Indeed, the indication of this technique is likely to be very limited but this case does demonstrate the importance of the lateral vascular pedicle in maintaining tracheal blood supply, showing the possibility of surgery for extremely difficult case.

#### Conflict of interest

None.

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#### Ethical approval

N/A.

#### Consent

This manuscript is not a study reports on patients, but a clinical reports showing the novel surgical technique.

#### Author contributions

Takushi Yasuda; writing all section of the manuscript and collecting of data.

Masayuki Shinaki; revising all section of the manuscript and collecting of data.

Osamu Shiraishi; making the figures.

Shunsuke Sogabe; drawing the illustrations.

**Research registry**

N/A.

**Guarantor**

Kiyotaka Okuno, who is the director of department of Surgery, Faculty of Medicine, Kinki University, accepts full responsibility for this case report along with Takushi Yasuda of the corresponding author of this manuscript.

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